Letter to the Editor

Pathogenism and Parasitism as Concepts of Symbiotic Relationships

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In 1940, The American Phytopathological Society (APS) Committee on Technical Words invited comment on a list of definitions of phytopathological terms (3). I propose to examine concepts of *parasitism* and to introduce a concept of *pathogenism*.

Associations among organisms exhibit varying degrees of intimacy and interdependence. At some level of intimacy of association we begin to recognize that the organisms share a common life; a *symbiosis*. This is the view of symbiosis adopted by deBary (4) and commended by many others (10). The partners of a symbiotic association are called symbionts.

The net effect of one symbiont upon the other may be beneficial, innocuous, or harmful. When the effects of each symbiont on the other are, so far as we can judge, beneficial, the relationship is referred to as *mutualism* (15). When one symbiont receives benefit from the other but confers no harm or benefit in return the relationship is referred to as *commensalism* (15). But what word shall we use to describe a relationship that is harmful to one of the symbionts? The term generally adopted in phytopathology is *parasitism*. I propose to argue that a more appropriate term is *pathogenism*.

Parasitism may be "the act or practice of a parasite" (15). Clearly, our concept of parasitism will depend on our concept of a parasite. Thrower (14) modified a definition offered by the British Mycological Society in 1950 (5) and defined a parasite as "an organism or virus existing in intimate association with another living organism from which it derives an essential part of the materials for its existence". Abercrombie et al. (1) defined a parasite as an "organism living in or on another organism (its host) from which it obtains food". The APS Committee on Technical Words (3) defined parasitism as "partial or complete nutritional dependence of one organism or virus on the tissues of another living individual". Tarr [(13), p. 185] claimed that "parasitism is basically a nutritional relationship between two organisms". Deverall [(6), p. 1] stated that "parasitism is the mode of life of an organism which lives on or in another living organism. The parasite derives at least part of its food from the host". According to these views "the act or practice of a parasite" (15) is the process of obtaining nutrient from its host and therefore, parasitism is a relationship in which one symbiont withdraws food from the other.

Other views include a statement as to the effect of the parasite on its host. A committee of the British Mycological Society (5) defined a parasite as an "organism or virus existing in intimate association with a living organism from which it derives an essential part of the material for its existence while conferring no benefit in return". This definition seems to include pathogenic and commensal symbionts. Abercrombie et al. (1) stated that "parasites may or may not be harmful to the host". Others clearly implicate production of disease as an act of a parasite (e.g., Wilbrink in 3). Gray (7) succinctly expressed this view by defining a parasite as "one organism which lives on another to the detriment of its host". The view of parasitism that arises from this concept of a parasite is of a symbiotic association in which unilateral feeding by one symbiont is accompanied by disease in the other.

The inclusion of two concepts, namely *feeding* and *production of disease*, within the term parasitism, can be traced back at least as far as deBary (4). He thought of parasites as organisms which "feed on living organisms whether plants or animals.....Their relationship with their hosts is that of a common life, a *symbiosis*" (p. 356). He then distinguished (p. 369) between "the parasitism which quickly destroys its victims and that in which parasite and host mutually and permanently further and support one another – the relation which ..... Van Beneden has termed *mutualism*". This suggests he thought of parasitism as the nutritional relationship common to all symbiotic associations. On the other hand he concluded from an analysis of diseases caused by fungi that (p. 369) "all these mycetogenous deformations and new formations and the phenomena also of simple destruction are in direct causal connection with the process of feeding the fungus". This comes close to implying that feeding causes disease.

There are, however, numerous examples (9, 12) which demonstrate that nutrient withdrawal (parasitism) and the capacity to produce disease (pathogenicity) can be distinguished in theory and in practice. Mycorrhizal fungi can withdraw nutrients from plants without inflicting recognizable damage on their host (8, 11). Microorganisms such as *Armillaria* (13), *Rhizobium* (13) and *Rhizoctonia* (2) may, according to circumstances, enter into either nonpathologic or pathologic relationships with higher plants, but nutrient withdrawal occurs in each situation.

I would suggest therefore that the term parasite be used broadly to refer to any symbiont that withdraws nutrient from its associated symbiont. This view is compatible with many others (1, 3, 4, 5, 6, 13, 14). Parasites that cause disease are pathogens, i.e. they are pathogenic parasites. Parasites, such as mycorrhizal fungi, that do not cause disease, are nonpathogenic parasites. The symbiotic relationship established between a parasite and its host is parasitism. In some cases parasitism is not accompanied by disease; such situations fall into categories such as commensalism and mutualism. But in many cases of parasitism the parasite does cause disease. I therefore propose pathogenism as a suitable term to describe those symbiotic relationships in which parasitism is accompanied by pathogenesis. Pathogenism, mutualism, and commensalism are terms of equal rank, referring to different types of symbiotic associations.

It should be emphasized that pathogenism is not synonymous with disease, or with pathogenesis (the production of disease), or with pathogenicity (the capacity to produce disease). It is synonymous with parasitism where this term has been used to describe

parasitic, pathologic, symbiotic relationships.

The following definitions summarize the proposed concept of pathogenism and meanings of parasite, pathogen, and parasitism consistent with this concept:

Pathogenism.—A parasitic, symbiotic relationship in which one symbiont causes disease in the other.

Parasitism.—The act or practice of a parasite; the parasitic state or condition; a relationship in which an organism of one kind lives in intimate association with an organism of another kind and from which it obtains food [adapted from (15)].

Pathogen.—An agent that incites disease.

Parasite.—"An organism or virus existing in intimate association with another living organism from which it derives an essential part of the material for its existence" (14).

The main purpose of this letter has been to draw attention to situations in which parasitism occurs in the absence of disease. The converse situation, i.e. disease in the absence of parasitism, also occurs. Most examples of nonparasitic organisms causing plant disease are probably covered by terminology proposed by Whittaker and Feeny (16) for chemical interactions between species.

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